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ELECTRON ENERGY TRANSFER RATES FOR VIBRATIONAL EXCITATION OF N_2

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The calculation of the electron density and electron temperature distribution in our ionosphere (from ≈150–600 km) requires a knowledge of the various heating, cooling and energy flow processes that occur. The energy transfer from electrons to neutral gases and ions is one of the dominant electron cooling processes in the ionosphere, and the role of vibrationally excited N_2 in this is particularly significant.

Previous studies on electron energy transfer rates (Q) for vibrational excitation of N_2 have been conducted by Stubbe and Varnum [1], Newton *et al.* [2] and Pavlov [3]. Unfortunately all these previous studies used cross sections which have been superceded. We will thus initially report on our recommended cross section matrix for vibrational excitation in N_2. This matrix is largely based on the compilation of Brunger and Buckman [4], extended for $0 \to 1$ to lower energies using the accurate calculation in Robertson *et al.* [5], and the data set of Ohmori *et al.* [6].

Using this recommended set the present electron energy transfer rates, as a function of the electron temperature T_e, for vibrational excitation of N_2 are calculated and the results compared against those from the previous studies [1–3]. An example of our data for the $0 \to 1$ excitation process, shown as a ratio to the respective results of Stubbe and Varnum, Newton *et al.* and Pavlov, is illustrated in figure 1. It is shown that the present Q differ significantly from those of the earlier studies [1–3]. Indeed we highlight that the current Maxwell-averaged rate for $0 \to 1$ (and this also holds for $0 \to 2,3,4,...10$) is substantially smaller than the results from Pavlov for Te < 3000K and substantially larger than the results of Stubbe and Varnum and of Newton *et al.* for $T_e > 3000$K. Practically, this means that people using the Pavlov rates will have overestimated the effect on the ionosphere of direct excitation of the N_2 vibrational levels in the lower half of the ionosphere.

The calculated rates were found to be very sensitive to the low energy tail of the cross sections. They were also found to be sensitive to the effects of the well-known low energy $^2\Pi_g$ resonance in N_2. The effect of the high-energy "tail" (*i.e.* E > 3.5 eV) of the cross sections and further key results from the current study will be presented.

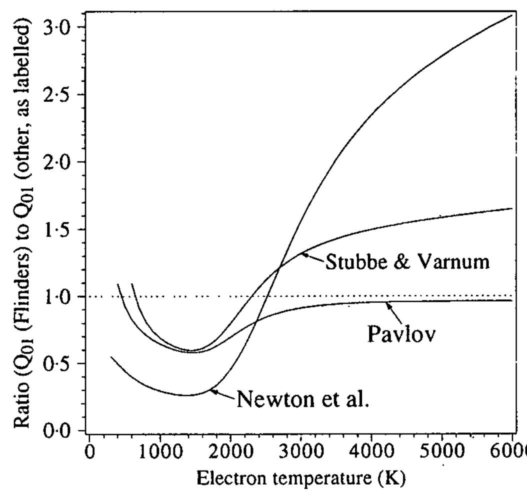

Fig. 1. Q versus T_e for $0 \to 1$ excitation in N_2. The ratio of the present results to those of the earlier studies [1–3] is plotted.

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